Ministry of
Transportation and
Communications

Ontario

REPORT EM-46

AGGREGATE PRODUCER'S PROCESS CONTROL OF AGGREGATE GRADATION

Engineering
Materials
Office

Ontario

Ministry of
Transportation and
Communications

Highway Engineering Division
Room 234, Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

April 29, 1981

Mr. F.J. DeWitt, President
Aggregate Producers' Association of Ontario
3701 Chesswood Drive, Suite 209
Downsview, Ontario
M3J 2P6

Dear Frank,

Last fall, in my letter of September 5th, I asked your Association to supply our Ministry with a list of Aggregate Producers who have regular sampling and testing programs for the control of product gradation.

At the end of October, we received this list which was greatly appreciated. Subsequent to this, several teams from the Ministry visited some 50 companies owning a total of 89 plants to obtain pertinent data. The findings of this survey are summarized in the enclosed report 'Aggregate Producers Process Control of Aggregate Gradation' for your information. The recommendations presented in the report have now been approved and adopted by the Ministry.

One of these recommendations is the gradual introduction of the voluntary Process Control by the Producer or Contractor on M.T.C. contracts. This would be preceeded by a few pilot projects to test the process. It is our suggestion that your Association, along with O.R.B.A., take a leading role in this effort.

It is realized that, since this idea is an entirely new concept for highway construction in the Province, a great deal of familiarization, training and planning will be required to implement it. The Ministry, of course, will make its expertise available should you desire to utilize it.

...2

To pursue the considerations related to commercial and wayside sources and the introduction of this concept on Ministry work we would like to meet with representatives of your Association and the O.R.B.A., after you have had an opportunity to review our findings to date.

With a copy of this letter, we will be forwarding a number of copies of the report to Mr. R.P. Cook for distribution, at your discretion. The reports are yet to be printed.

If you require any further information, additional copies of the report, or wish to discuss Process Control with us, please contact Mr. A.G. Stermac, Manager, Engineering Materials Office (Tel. 248-3987).

After you have had an opportunity to review the report we will arrange a meeting, hopefully in June '81.

Yours sincerely,

F.G. Allen,
Executive Director,
Highway Engineering Division.

Encls/

cc: R.P. Cook.

Ontario

Ministry of
Transportation and
Communications

Highway Engineering Division
Room 234, Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

April 29 , 1981

Mr. H. Macpherson, President
Ontario Road Builders Association
325 Eddystone Avenue
Downsview, Ontario
M3N 1H8

Dear Hugh,

Last fall and winter, our Ministry conducted a survey of process control of aggregate gradation carried out by commercial Aggregate Producers. This was done with the co-operation of the Aggregate Producers Association of Ontario. The Association sent out a preliminary questionnaire to its members. This was followed up with visits by three teams from our Ministry to some 50 Aggregate Producers owning a total of 89 plants. The findings of this survey are summarized in the enclosed report 'Aggregate Producers Process Control of Aggregate Gradation' for your information. The recommendations presented in the report have now been approved and adopted by the Ministry.

One of these recommendations is the gradual introduction of voluntary Process Control by the Producer or Contractor on M.T.C. contracts. This would be preceeded by a few pilot projects to test the process. It is our suggestion that your Association, along with A.P.A.O., take a leading role in this effort.

It is realized that, since this idea is an entirely new concept for highway construction in the Province, a great deal of familiarization, training and planning will be required to implement it. The Ministry, of course, will make its expertise available should you desire to utilize it.

...2

To pursue the considerations related to commercial and wayside sources and the introduction of this concept on Ministry work we would like to meet with representatives of your Association and the A.P.A.C., after you have had an opportunity to review our findings to date.

With a copy of this letter, we will be forwarding a number of copies of the report to Mr. M.F. Macdonald for distribution, at your discretion. The reports are yet to be printed..

If you require any further information, additional copies of the report, or wish to discuss Process Control with us, please contact Mr. A.G. Stermac, Manager, Engineering Materials Office (Tel. 248-3987).

After you have had an opportunity to review the report we will arrange a meeting, hopefully in June '81.

Yours sincerely,

F.G. Allen,
Executive Director,
Highway Engineering Division.

Encls/

cc: Mr. M.F. MacDonald

AGGREGATE PRODUCER'S PROCESS CONTROL OF AGGREGATE GRADATION

by

A.K. Barsvary, P. Eng.
Senior Soils Engineer

and

Z.L. Katona, P. Eng.
Senior Aggregate Resources Engineer

SOILS AND AGGREGATES SECTION
ENGINEERING MATERIALS OFFICE

April, 1981

LIST OF CONTENTS

		Page No.
(1)	INTRODUCTION	1
(2)	BACKGROUND AND OUTLINE OF QUALITY ASSURANCE SPECIFICATIONS	2
(3)	INTERVIEWS WITH AGGREGATE PRODUCERS	6
(4)	DISCUSSION AND EVALUATION OF THE INTERVIEWS	12
(5)	RECOMMENDATIONS	17
(6)	ACKNOWLEDGEMENTS	19
(7)	APPENDIX	22

(1) INTRODUCTION

A meeting was held on 80 08 21, chaired by Mr. F.G. Allen, Executive Director, Highway Engineering Division, to discuss the aggregate producers' process control of aggregate gradation. It was identified and agreed by the attendees that the Ministry's objective is to move towards a better process control by aggregate producers, leading to an eventual reduction in M.T.C. acceptance testing of gradation. To this end, it was decided at the meeting that a survey of current testing practices by producers, and their existing laboratory facilities should be undertaken. This intention was communicated to the Aggregate Producers' Association of Ontario (A.P.A.O.) in a letter signed by Mr. Allen, requesting the Association's co-operation. (Copy attached as Appendix A). In complying with this request, Mr. F.J. DeWitt, President of A.P.A.O. kindly supplied the Ministry with a list of those producers who carry out gradation tests in their own laboratories. Producers currently having some process control by gradation testing were visited by members of the Soils and Aggregates Section, in order to obtain detailed information as to their laboratories, test procedures, frequency of testing and related data.

Presented in this report is: - some background information, description of the interviews, discussion and evaluation of the collected information and recommendations for further action.

(2) BACKGROUND AND OUTLINE OF QUALITY ASSURANCE SPECIFICATIONS

(2.1) In the traditional 'material and method' type of specification, the quality of a construction material is usually controlled by taking 'representative' samples to show average conditions. The choice of sample location depends on the judgement of the Inspector, thus, the test result of such a sample can be BIASED by his attitude or procedure. Decisions of acceptance or rejection are made on the results of individual tests without any consideration of the variability of the material.

Realizing the fallacy and serious shortcoming of the traditional acceptance procedure, and following the lead of U.S.A. experiences, a gradual change-over has taken place in the Ministry, from our 'material and method' type of specification to a quality assurance system, using statistical probabilities. Developments so far have been limited to gradation acceptance of base and subbase aggregates and the control of aggregate and earth compaction.

Any quality assurance specification is based on the recognition that all construction processes and materials by their very nature are variable. Since there is an additional cost associated with increasing quality levels, economically balanced and realistic tolerances are set for acceptance. The control and acceptances of processes and materials are usually carried out by truly random sampling and testing of a work segment, called a lot, determining acceptability by means of

the average value of tests within the lot. Acceptance limits are set realistically for full acceptance and acceptance with adjusted payment.

The quality assurance system clearly delineates the responsibilities with respect to process or quality control and inspection or acceptance sampling and testing. Since the contractor (or material supplier) has the most direct effect on the quality of work, he therefore is responsible for exercising process control. The highway agency acts as a legal agent of the buyer - the taxpayer - performing inspection and testing, to ensure the specified level of product quality.

Most U.S.A. Highway Agencies that have adopted statistically based quality assurance specifications require contractors and material suppliers to submit process control plans to qualify for consideration on contracts.

Process control by the industry is best implemented on a strictly voluntary basis, with close co-operation between the Trade Association and the Highway Agency. There is ample documented evidence, published in journals and reports, which indicates that a mutually agreeable process control program is cost effective after the first few years, and will have clearly identified benefits for both the industry and the contracting agency.

(2.2) In considering the introduction of a process control program operated by the aggregate producers of Ontario, it

is important that their Association (A.P.A.O.) takes the lead in providing guidance and technical counsel to those members who voluntarily wish to participate in the development of such a plan. The Ministry in turn - if requested by the Industry - should make its expertise available to the industrial sector in guiding and assisting in the development and implementation of the program.

It is not intended to discuss a process control plan in detail at this time, but some of the principal requirements for such a scheme are given below, mainly to help the interested parties in their consideration and decision-making:

(a) In order to be accepted for process control, each plant or producer must have an approved laboratory.

(b) Sampling and testing personnel must be properly trained and duly certified.

(c) Laboratory testing must be performed according to mutually agreed and accepted procedures.

(d) Samples must be taken on a random basis and the frequency of sampling must be according to mutually agreed and accepted practice. The frequency is to be based on the past performance of the produced material and the variability of the product.

(e) Interpretation of the test results and the documentation technique (moving average, lot by lot, central tendency and range control charting, etc.) must be commensurate with the Ministry's Special Provision or guidelines.

(f) A method should be developed to detect and eliminate factors in the process that could cause unacceptable variation of the gradation of the product.

Carefully designed and well executed contractor/producer process control systems have been most effective in the U.S.A. In many instances, process control sampling and testing of aggregate gradations were so well controlled, that no further testing for acceptance by the Highway Agency was necessary. In these cases, the Highway Agency carried out periodic correlation tests only.

Giving more responsibilities to the aggregate producer for controlling his own product, is in agreement with the Ministry's privatization policy and would result in an eventual reduction of M.T.C. manpower involved in quality assurance. (e.g., One U.S.A. D.O.T. used to have about 400 inspectors testing aggregate. After the full implementation of contractor/producer process control program, the number of inspectors was gradually reduced to 12).

Contractor/supplier process control adopted on a voluntary basis would necessitate a change-over period. This change-over could be divided into three phases.

In the first phase, some producers would have an acceptable plan, some would not. M.T.C. would still carry out all the process control testing - as is done today - for those with no plan.

In the next phase of implementation, M.T.C. would specify that process control is the responsibility of the contractor or the producer. The contractor or the producer then would have the option of setting up his own system, or if he deems it more desirable, of electing to contract a private laboratory to perform sampling and testing. In this phase, M.T.C. may still carry out process control functions, but would charge the contractor who chose not to employ a consultant for sampling and testing.

In the third phase, all process control activities would be carried out either by the contractor/producer or by a private testing company without M.T.C. involvement.

Acceptance of the materials of course would remain the responsibility of the Ministry.

The implementation schedule and extent to which the Ministry would reduce its efforts to acceptance testing would depend on the ability of the industry to control the consistent quality of its product and the expected economy of the transition.

(3) INTERVIEWS WITH AGGREGATE PRODUCERS

(3.1) The 1980 A.P.A.O. Directory of Active members lists some 123 companies producing granular base and subbase aggregates (Granular A, B and C, and 16 mm crushed type B). The 123 companies represent a total of 175 sand and gravel plants and rock quarries.

As it was indicated in the Introduction, all of these companies received a questionnaire from A.P.A.O. in September of last year pertaining to process control. All of the returned questionnaires were kindly forwarded to this office by the A.P.A.O. with the approval and encouragement that Ministry representatives should visit the responding companies to obtain detailed information concerning laboratory facilities, testing personnel, test methods, etc.

Among the returned A.P.A.O. questionnaires, 50 companies owning a total of 89 plants indicated that they carry out some process control testing. The above number of plants is 51% of the total.

All companies indicating that they have process control testing were visited by teams from the Soils and Aggregates Section, with a prepared questionnaire (attached as Appendix B).

(3.2) For meaningful data collection, the companies were grouped into three sizes - small, medium and large. Companies producing less than 500,000 tons annually are listed as small. Companies with a yearly production of between 500,00 and 1,000,000 tons are medium, while the large companies produce over 1,000,000 tons per annum.

It was deemed to be of particular importance to ascertain whether the various companies sell a small or large portion of their products for M.T.C. or M.T.C.-subsidized projects. It was felt that any M.T.C. policy change concerning aggregates would have very little impact on producers selling less than

25% of their production to the Ministry. The impact would be, however, significant for those companies selling more than 50% of their annual production for M.T.C. jobs. The breakdown by size and by the production for M.T.C. or M.T.C.-subsidized projects is shown in Table 1.

SIZE OF PRODUCER	SMALL			MEDIUM			LARGE		
TOTAL NUMBER OF PLANTS	25			13			22		
% OF TOTAL AGGREGATES PRODUCED FOR M.T.C.	< 25	25-50	> 50	< 25	25-50	> 50	< 25	25-50	> 50
NUMBER OF PLANTS	10	10	5	3	6	4	8	10	4

Table 1

Table 1 shows that the largest number of plants (25) were classified as small, closely followed by large operations (22). These numbers might be somewhat misleading when one considers the quantities of aggregates produced. The 25 small plants produce approximately 2.5 million tons/year for M.T.C. and municipal work. The corresponding quantities produced by the large plants, on the other hand, amount to over 10 million tons per annum. The total production of the medium size plants is about 5.5 million tons/year for M.T.C. work.

(3.3) All the visited producers were found to have some laboratory facilities of their own. A thorough study of the laboratories revealed that a large number of the facilities were in excellent or very good condition having both adequate laboratory buildings and well kept and up-to-date equipment.

These laboratories would require only minor adjustments and small expenditures to raise them to a certifiable level.

On the other hand, some of the laboratories visited would require major improvements, including laboratory premises and testing equipment. In the case of the latter companies, it is estimated that, in order to bring their laboratories to a level acceptable for process control, they would require expenditures in excess of $2,000. Less than 2% of the plants visited had only rudimentary testing facilities without laboratory premises.

Table 2 shows the improvements required of the different size producers.

SIZE OF PRODUCER	SMALL		MEDIUM		LARGE	
IMPROVEMENT REQUIRED TO LABORATORIES	MINOR	MAJOR	MINOR	MAJOR	MINOR	MAJOR
NUMBER OF LABORATORIES	14	12	9	3	17	5

Table 2

The Table indicates that, among the 60 laboratories visited, 20 would require major improvements (over $2,000), while 40 laboratories would need only minor adjustments for certification.

(3.4) More than 90% of the producers assign permanent employees for testing of aggregates. Persons carrying out sampling and testing were trained on the job, with a small minority having received additional formal training at community colleges or trade organizations. Most of the personnel

employed in sampling and testing usually carry out other duties when time permits. Only 12% of the producers utilize their technicians full time and sampling and testing.

(3.5) All of the producers visited carry out some gradation testing. The average frequency of gradation testing is shown in Table 3. Since the frequency of testing was found to be highly variable among the producers, the average frequencies are tabulated separately for the various aggregate products.

It is to be noted that the frequencies shown refer to the time period of production of the particular aggregate. More frequent sampling and testing is carried out during the early production stage (i.e., set-up of the equipment).

By examining Table 3, it becomes apparent that more frequent testing is being carried out for concrete and H.L. aggregates than for granular base and subbases. The more frequent testing of concrete and H.L. aggregates is in accordance with the specified closer control of gradation of these aggregates as well as higher market value.

A great number of producers perform gradation testing once or more per day. Also, a great many producers pointed out to M.T.C. interviewers that the reason for their infrequent testing is the current Ministry policy. At the present time, the Ministry disregards the producers' test results and whether the aggregate was tested by the producer or not, M.T.C. carries out frequent gradation tests for acceptance.

MAT'L TYPE	TESTING FREQUENCIES	NUMBER OF PRODUCERS			
		SMALL	MEDIUM	LARGE	TOTAL
GRANULAR BASE	1 OR MORE DAILY	10	6	9	25
	1 OR 2 WEEKLY	5	4	6	15
	OCCASIONALLY OR AS REQUIRED	5	2	4	11
GRANULAR SUBBASE	1 OR MORE DAILY	4	3	5	12
	1 OR 2 WEEKLY	2	2	5	9
	OCCASIONALLY OR AS REQUIRED	8	4	2	14
H.L.	1 OR MORE DAILY	14	7	13	34
	1 OR 2 WEEKLY	0	5	3	8
	OCCASIONALLY OR AS REQUIRED	3	2	2	7
CONCRETE	1 OR MORE DAILY	16	5	13	34
	1 OR 2 WEEKLY	2	4	3	9
	OCCASIONALLY OR AS REQUIRED	3	2	1	6

Table 3

With regards to gradation testing, it was found that the great majority of the aggregate producers follow procedures similar to M.T.C. methods with one exception, namely, the washing of the fine aggregate through the 75 µm sieve. Only 10% of the producers use the washing technique regularly,

while 43% employ dry sieving only. Most of the laboratories have washing facilities consequently, the washing of the fine aggregate could be easily adopted, if so required.

The main emphasis of the survey was placed on gradation testing, nevertheless, it was found that about 30% of the producers carry out a variety of other tests. While the discussion of these tests is outside the scope of this report, the various tests performed by some producers are listed as follows:

- Proctor Test
- % Crushed Particles
- Moisture Content
- Wash Pass 75 µm of coarse aggregate
- Flat & Elongated Particles Content
- Soundness Loss
- Organic Impurities Content
- Concrete Cylinder Compression Tests
- Petrographic Analysis
- Relative Density Test
- Asphalt Stripping of Coarse Aggregate
- Extraction Test
- Fineness Modulus

(4) DISCUSSION AND EVALUATION OF THE INTERVIEWS

(4.1) The principal finding of the investigation has been the fact that more than 50% of the plants producing granular base and subbase aggregates carry out some process control

testing of gradation in their own laboratories by their own technicians. The majority of the producers control gradation of granular base and subbase aggregates on the basis of individual test results. If a test complies with the M.T.C. gradation specification, the process is considered to be in control, if it does not, then prompt adjustment is made to the process. Since M.T.C. acceptability is based on the average of four samples being within the specification limits, the present control by the producers is more stringent than the Ministry's. It was also found that a few producers use a daily average of gradation test results for process control.

(4.2) Most of the producers realize that their gradation test results are currently disregarded by the Ministry, consequently, some of them are quite reluctant to increase the frequency of testing in view of existing M.T.C. policy. To illustrate the unnecessary duplication of tests, an actual example is given below.

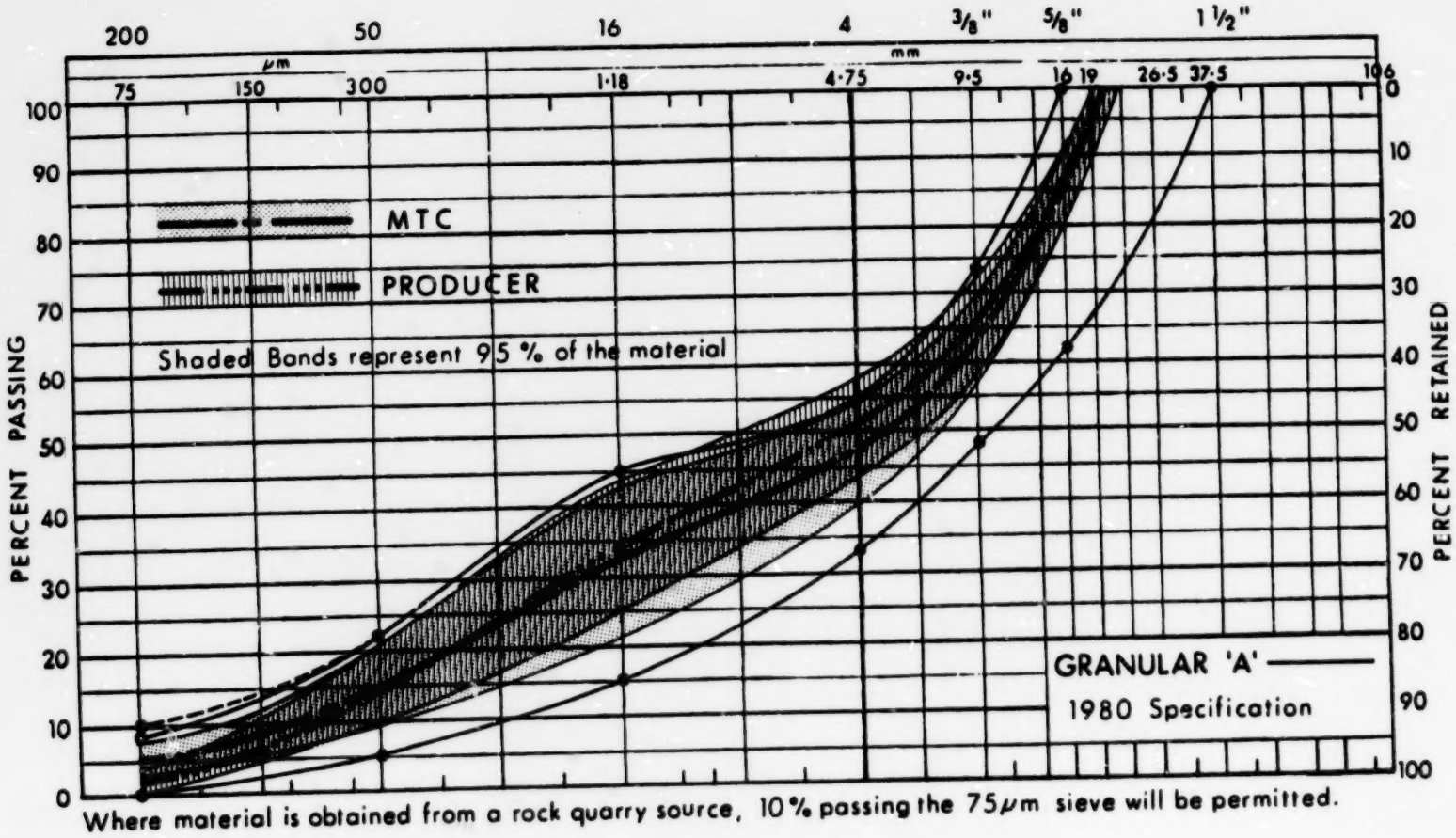
One aggregate producer interviewed carried out very frequent gradation tests in his own laboratory on granular A supplied to a nearby M.T.C. contract in 1980. The medium size sand and gravel plant is equipped with a good laboratory and manned by an experienced technician. The frequency of testing was the same as the frequency specified by the 1980 Ministry's guidelines for acceptance. The producer has made his test results available to the M.T.C. so that both sets of values - producer's as well as M.T.C.'s - could be statistically analyzed. Individual test results of the producer

were chronologically grouped in lots, and the mean of the four tests within each lot was computed. The analysis was carried out by using the mean of each lot, in order to obtain the central tendency ($\bar{x}$) and the standard deviation (σ) on the designated sieves, separately for the M.T.C.'s and producer's tests. Both M.T.C. and the producer had 25 lots, a total of 100 tests for each. The statistical parameters ($\bar{x}$ & σ) of the lot values (n = 25) are listed in Table 4.

SIEVE SIZE	PRODUCER'S TESTS		M.T.C. TESTS	
	$\bar{X}$	σ	$\bar{X}$	σ
16 mm	86.3	2.3	85.9	2.3
9.5 mm	65.0	4.3	63.1	3.3
4.75 mm	50.7	3.5	47.3	3.9
1.18 mm	33.9	4.2	31.7	5.1
300 μm	14.9	2.7	15.1	3.0
75 μm	2.4	0.5	5.6	1.0

Table 4

As it may be seen, the producer's test results are in a very close agreement with the M.T.C. results, except on the 75 µm sieve. The latter discrepancy was caused by the method of testing. The producer carried out dry sieving, while the M.T.C. method calls for separating the fines by washing technique. In Figure 1, the gradation curves of the two sets of tests are shown for comparison. The gradation bands represent 95% of the materials ($\pm$ 2σ limit). According to our own test results, three lots were very slightly outside the



Where material is obtained from a rock quarry source, 10% passing the 75μm sieve will be permitted.

FIG. 1
GRADATION CURVES

specification band. Had we adopted the producer's results for acceptance, four lots would have been outside, and would have resulted in some moderate payment adjustment.

The opportunity to analyse and compare the producer's and our own test results illustrates that, in this or similar circumstances, duplicate testing program is not necessary, in fact, it is wasteful. (In the above case, the elimination of duplicate testing would have resulted in an approximate saving of $4,500.00.)

(4.3) All of the producers interviewed welcomed the M.T.C. teams and were most co-operative in supplying information. Most of them were keenly interested in the prospect of having more responsibility for a process control plan.

After a brief description of a proper process control plan was given by the interviewer, each producer was asked whether or not he would wish to participate in such a plan. Some 70% of the producers answered the question with "yes". Some 10% of the producers, while replying in the affirmative, expressed some reservation. Those producers indicated that they would like to know more about the system before committing themselves. All of the producers that indicated interest in process control strongly felt that, for the development of the system, the Ministry's guidance, assistance and counsel will be an essential requirement.

20% of the producers did not wish to participate in a process control plan at this time. The majority of these producers are relatively small organizations or producers

selling only a small portion of their products for M.T.C. or M.T.C.-subsidized work.

(4.4) In order to obtain some practical experience in process control, it was proposed to the producers that some joint pilot projects be implemented to test the system in 1981. Some 70% of the producers indicated that they would be willing to participate in such undertaking. Their willingness was expressed with the full understanding that more frequent testing and, in some cases, improvement to the laboratory facilities would be required.

(5) RECOMMENDATIONS

As a corollary to our intensive studies of existing process control systems, and as a result of the recent interviews with Ontario Aggregate Producers, we are submitting the following recommendations for consideration:

(a) The Ministry should adopt the principle that the producer or the contractor bears the responsibility for providing the necessary tests, inspections and documentation to ascertain the conformance of the material supplied to the relevant specifications, within the framework of an approved Process Control Program. The Ministry should assure the quality of the delivered material by auditing the producer's test data, by periodic inspection and by verification testing.

(b) The Ministry should communicate the above policy to the Ontario Road Builders Association (O.R.B.A.) and the Aggregate Producers Association of Ontario (A.P.A.O.), pointing out that this policy has been endorsed by a large segment of the members of A.P.A.O.

(c) The producer/contractor Process Control Program should be introduced and tested gradually, spearheaded during the first years by voluntary participation. At this time, only the control of gradation of base and subbase aggregates should be considered. O.R.B.A. and A.P.A.O. should assume a leading role in the introduction, development and promotion of the program. The Ministry should make its expertise available to industry by suggesting that committees or task forces be established, manned by both the industrial sector and Ministry representatives, to develop and evaluate the system.

(d) Since many aggregate producers have shown a great deal of interest in testing the proposed Process Control Program, approval should be granted to conduct a few pilot projects during the next construction season. Naturally, these projects should also be set up on a voluntary basis. Where these projects are implemented, gradation testing would be carried out by the contractor or the commercial aggregate producer on the contractor's behalf,

as well as by the Ministry. Test results then could be analysed and evaluated, the system de-bugged and refined. The projects would serve as good examples for M.T.C. as well as for the producers in the development of typical process control systems.

(6) ACKNOWLEDGEMENTS

The preparation of a large portion of this report was made possible by the willing co-operation, the keen interest and support of all aggregate producers visited by the M.T.C. teams. Grateful appreciation is extended to the representatives of the following companies:

- Armbro Aggregates - (Division of Armbro Materials and Construction Limited)
- Bertrand & Frere Const. Co. Ltd.
- Bright Sand and Gravel Ltd.
- Caledon Sand & Gravel
- Canada Crushed Stone - (Division of Streetley Industries Limited)
- Cedarhurst Quarries and Crushing Limited
- Allan G. Cook Limited
- Cornwall Gravel Company Limited
- Custom Aggregate
- Dibblee Construction Company Limited
- James Dick Construction Company Limited
- Donegan's Haulage Ltd.
- George W. Drummond Limited
- Dufferin Aggregates

- Fowler Construction Company Limited
- Francon - (Division of Canfarge Ltd.)
- Gormley Sand and Gravel Limited
- Hancock Sand and Gravel Limited
- Hard Rock Paving Co. Ltd.
- Harnden & King Construction Ltd.
- Highland Creek Sand and Gravel Co. Limited
- Huron Gravel Limited
- W. Robert Hutcheson Sand and Gravel
- Indusmin Limited
- K-W Blair Ready Mix (1973) Ltd.
- Kam Aggregates Ltd.
- E.C. King Contracting Ltd.
- King Paving and Materials
- Lee Sand and Gravel Limited
- Marshall Aggregates - (Division of Mar-Fam Industries Ltd.)
- McColgan Sand and Gravel Ltd.
- H.J. McFarland Construction Co. Ltd.
- Milton Limestone
- James Murray Construction Ltd.
- Oxford Sand and Gravel Ltd.
- Permanent Concrete
- Port Colborne Quarries Limited
- Preston Sand and Gravel Company Limited
- Repac Construction and Materials Limited
- Ridgemount Quarries Limited

- Sherman Sand and Gravel Limited
- Spratt Sand and Gravel Limited
- Standard Aggregates - (Division of Standard Industries Limited)
- Standard Paving Co. - (Division of Standard Industries Limited)
- Superior Sand, Gravel and Supplies Limited
- TCG Materials Limited
- Taro Properties Incorporated
- Vineland Quarries and Crushed Stone Ltd.
- Walker Brothers Quarries Limited
- Yundt Brothers Construction Limited

Apart from the authors, members of the M.T.C. interviewing teams were as follows:

- Mrs. Z. Koniuszy, P. Eng.
- J.D. Dainton
- W.F. Deike
- H.D. Reed

Their conscientious contribution is greatly appreciated.

(7) APPENDIX

Appendix A

Ontario

Ministry of
Transportation and
Communications

Highway Engineering Division
Room 234, Central Building,
1201 Wilson Avenue,
Downsview, Ontario
M3M 1J8

September 5, 1980.

Mr. F.J. DeWitt, President,
Aggregate Producers' Association of Ontario,
3701 Chesswood Drive, Suite 209,
Downsview, Ontario, M3J 2P6

Dear Frank:

The 1979 Interim Guidelines, and 1980 Guidelines that we have developed with the co-operation of the aggregate and roadbuilding industry have concentrated on establishing uniform and realistic acceptance procedures for granular materials. You will recall, though, that on many of the occasions when we have met with you over the past two to three years to discuss quality assurance, the Ministry has also expressed its interest in developing a stronger role in process control for the producer and/or contractor. Mr. Wilkes emphasized this again when he addressed the ORBA Convention this April.

I believe that your Association would also wish to see the aggregate producing industry increase its control of the quality of its product. I notice, for example, that this is mentioned in the minutes of a meeting in June with the APAO Specifications and Marketing Committee.

At the moment we do not have good information on the extent of process control by aggregate producers, and this is a situation which, with your assistance, we would like to remedy. Our staff have visited some plants, but in order that we can begin to compile a comprehensive inventory it would be very helpful if your Association could supply us with a list of those aggregate producers who have a regular sampling and testing program for the control of product gradation. We would then make our own contacts with these firms to obtain detailed information.

.....2

Having prepared this inventory we shall contact you again with a view to discussing ways in which the aggregates industry can improve its ability to comply with Ministry's requirements, and so assume a greater responsibility for the acceptability of its products.

As we would like to make as many plant visits as we can this season, we would appreciate getting this information as soon as you can conveniently make it available to us.

Yours sincerely,

Original Signed
F. G. ALLEN

F.G. Allen
Executive Director,
Highway Engineering Division

FGA:mlm

CC: Messrs: L.R. Eadie
E.J. Orr
A.G. Stermac
T.J. Kovich
D.F. Lynch
A.G. Kelly
L.M. Peverett

PROCESS CONTROL QUESTIONNAIRE FOR COMMERCIAL AGGREGATE PRODUCERS

Name of Producer _____

M.T.C. Mineral Aggregate Inventory Code No. _____

Location of Plant _____

_____ Telephone No. _____

Names and Positions interviewed _____

1. Type of Aggregate Source: Pit ☐ , Quarry ☐ , Slag Processor ☐ .
2. General Description of Raw Aggregate in Situ:
   Sand ☐ , Sandy Gravel ☐ , Coarse Gravel ☐ , Rock ☐ , Slag ☐ .
3. Type of Excavation: Above Water ☐ , Below Water ☐ , Both ☐ .
4. Method of Stockpiling:
   Conical Piles ☐ , Stackers ☐ , Bins ☐ , M.T.C. Layer Method ☐ ,
   Other ☐ (Specify) _____
5. Types of Products Sold:
   Pit Run ☐ , Crusher Run ☐ , Co. Agg. ☐ , Fi. Agg. ☐ .
6. Approximate Tonnes Sold/Annum:
   Under 100,000 ☐ , 100,000-500,000 ☐ , 500,000-1,000,000 ☐ , Over 1,000,000 ☐ .
7. Percentage of Aggregates Sold for M.T.C. or M.T.C. Subsidized Contracts:
   0-25 ☐ , 25-50 ☐ , 50-75 ☐ , 75-100 ☐ .
8. Breakdown of This Percentage:
   Gran. Subbase: _____ %
   Gran. Base: _____ %
   H.L. Co. & Fi. Agg.: _____ %
   Conc. Co. & Fi. Agg.: _____ %
9. Aggregate Gradation Tests Performed? Yes ☐ , No ☐ .
10. If Answer to Question is Yes, By What Means?
    Own Lab. in Plant ☐ , Own Lab. at another Plant ☐ , Private Testing Lab. ☐ .
11. By What Method are Samples Obtained?
    End of Belt ☐ , Stopped Belt ☐ , Stockpile (Spiralled) ☐ , Pit Face ☐ ,
    Truck ☐ , Railway Car ☐ , Other ☐ (Specify) _____

12. How Often are the Tests Done? _____

_____

13. What is the Frequency of Testing for Various Products Used on M.T.C. Contracts?

Granular Subbase _____

Granular Base _____

H.L. Co. & Fi. Agg. _____

Conc. Co. & Fi. Agg. _____

14. For Determining Gradation, are the Test Results of One Sample ☐ or Arithmetic Mean of More Than One Sample Used ☐ ?

If More Than One Sample, How Many are Used? _____

15. Any Standardized Forms or Documents Used for Recording Test Results?

Yes ☐, No ☐. If Yes Please Supply Copies.

16. What is the Position of Personnel Responsible for the Testing?

Permanent ☐, Part Time ☐, Others ☐ (Specify) _____

_____

17. What Type of Training Did Tester Receive?

On the Job ☐, Formal (Comm. College etc.) ☐, Others ☐ (Specify) _____

_____

18. Does the Tester Carry Out Other Duties? Yes ☐, No ☐.

19. Control Chart Used? Yes ☐, No ☐. If Yes Please Supply Copies.

20. Any Other Charts Used? Yes ☐, No ☐. If Yes Please Supply Copies.

21. If the Arithmetic Mean of More Than One Sample is Used, is the Moving Average Determined? Yes ☐, No ☐.

22. Is the Fine Aggregate Portion of Granular Base and Subbase Materials Washed in the Sieve Analysis? Always ☐, Sometimes ☐, Depends on Circumstances ☐, Never ☐.

23. What Action is Taken if the Sample That Was Tested is Outside M.T.C. Specifications? _____

_____

_____

_____

24. If the Plant has Its Own Laboratory, What is its Floor Space?

_____ X _____ (in feet) or _____ sq. ft.

25. Type of Laboratory Equipment (Check on Attached List.)

26. Do you Perform Tests other than Gradation? Yes ☐, No ☐.

If Answer is Yes Specify Types _____

_____

_____

27. If the Company has More Than One Plant Do Each of These Have Their Own Laboratory? Yes ☐, No ☐.

28. Would the Company Be in Favour of a Process Control Program Run by the Company as the Means of Acceptance of Granular Base and Subbase Aggregates? Yes ☐, No ☐.

Remarks _____

_____

_____

_____

29. Should the Answer Be Yes, Would the Company Be Interested in Receiving Assistance From M.T.C. in the Development of Such a Program? Yes ☐, No ☐.

Remarks _____

_____

_____

30. General Remarks: _____

_____

_____

_____

_____

_____

_____

_____

Laboratory Equipment for Sieve Analysis of Aggregates. (M.T.C. Method LS-602)

1. Sieves, square opening, 12" diameter, 2" deep.

106 mm (4")	26.5 mm (1")	9.5 mm (3/8")	
75 mm (3")	22.4 mm (7/8")	6.7 mm (No.3)	
63 mm (2½")	19 mm (3/4")	4.75 mm (No.4)	
53 mm (2")	16 mm (5/8")	+ 1 lid and pan.	
37.5 mm (1½")	13.2 mm (½")		$634.00

2. Sieves, 8" diameter (Half-height)

2.36 µm (No. 8)	300 µm (No. 50)	
1.18 µm (No. 16)	150 µm (No. 100)	
600 µm (No. 30)	75 µm (No. 200)	
	+ 1 lid and pan.	$127.00

3. Wooden Rocker Box for large sieves. (can be home made.)

4. Motorized mechanical Sieve Shaker for small sieves. $400.00

5. Splitter to reduce passing 4.75 mm (#4). $236.00

6. Drying Oven. $800.00

7. Receivers for sieved material. (13 bowls of approx. 15" diameter & 6 bowls of approx. 9" diameter.

8. Scale, Toledo, accurate within 0.1% of test load (up to 50 lbs.) $1200.00 + weights

9. Balance, accurate within 0.1% of test load (up to 1000 g). $600.00 electronic mechanical

10. Sieve 12" diameter, 75 µm to wash passing 4.75 mm material. $46.00

11. Sieve calculation cards.

12. Rubber mallet.

13. Stiff brush.

14. Spatula.

15. Large Pans for drying bulk samples.

16. Washing facilities.

Approx. total cost $4000. - $4500.00.